REPLACED BY ART 34 AMDT.

CLAIMS

What is claimed is:

1.A method for multiline transmission, comprising:

calculating eigenvalues to maximize equalized channel impulse response;

identifying eigenvectors associated with dominant eigenvalues;

combining the eigenvectors into a subspace; and

performing optimization over the subspace to calculate subspace time equalizer coefficients.

AMENDED CLAIMS
[received by the International Bureau on 12 November 2003 (12.11.03);
original claims 1 replaced by amended claims 1-72 (13 pages)]

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1. A method, comprising mitigating spectral leakage in DMT (Discrete Multi-Tone) receivers, wherein mitigating spectral leakage comprises designing a receiver window to reduce edge effects of an IFFT/FFT transformation.

2. The method of claim 1, further comprising: designing a shape of the receiver window by maximizing a bitrate of a DMT system for a given set of disturber environments.

3. The method of claim 1, further comprising: determining a length of the receiver window by maximizing a bitrate of a DMT system for the given set of disturber environments.

4. The method of claim 1, further comprising:

applying the receiver window to a received signal in a time domain; and

using a FFT to convert the received signal into a frequency-domain symbol.

5. The method of claim 4, wherein the shape of the receiver window is linear.

6. The method of claim 4, wherein the length of the receiver window is between 5 and 20 samples.

7. The method of claim 4, further comprising reducing the length of the receiver window by not including 0 as a first coefficient or 1 as a last coefficient in receiver window coefficients.

8. The method of claim 7, further comprising:

multiplying samples in a last part of a prefix of the received signal by the receiver window coefficients to generate a first result;

multiplying the samples in the last part by the receiver window coefficients subtracted from 1 to generate a second result; and

adding the first result and second result to generate modified samples; and

substituting the modified samples into the last part of the received signal.

9. The method of claim 1, further comprising using the receiver window in a multiline communications system having multiple twisted copper pairs as a single multiline communications channel, and physical-layer signals coordinated across multiple transmitters and/or across multiple receivers.

10. The method of claim 9, further comprising using the receiver window to mitigate spectral leakage across one or more frequency bins and across one or more receivers of the multiline communications system.

11. The method of claim 9, further comprising determining a shape of the receiver window by maximizing a bitrate of a DMT system for a given set of disturber environments.

12. The method of claim 9, determining a length of the receiver window by maximizing a bitrate of a DMT system for the given set of disturber environments.

13. The method of claim 9, further comprising:
applying the receiver window to a received signal in a time domain; and
using a FFT to convert the received signal into a frequency-domain symbol.

14. The method of claim 13, wherein the shape of the receiver window is linear.

15. The method of claim 13, wherein the length of the receiver window is between 5 and 20 samples.

16. The method of claim 13, further comprising reducing the length of the receiver window by not including 0 as a first coefficient or 1 as a last coefficient in receiver window coefficients.

17. The method of claim 13, further comprising:
multiplying samples in a last part of a prefix of the received signal by the receiver window coefficients to generate a first result;
multiplying the samples in the last part by the receiver window coefficients subtracted from 1 to generate a second result; and

adding the first result and second result to generate modified samples; and substituting the modified samples into the last part of the received signal.

18. A method, comprising:

mitigating crosstalk between multiple lines of a multiline communications system, comprising using a Zipper scheme, including a prefix and suffix, to synchronize transmitters and receivers across the multiple lines of the multiline communications system, wherein the multiline communications system has multiple twisted copper pairs as a single multiline communications channel, and physical layer signals coordinated across multiple transmitters and/or across multiple receivers.

19. The method of claim 18, further comprising:

using a transmission scheme with non-overlapped upstream and downstream spectra; and

mitigating self-echo to each receiver of the two or more receivers using the Zipper scheme, wherein the self-echo is caused by a transmitter corresponding to each receiver of the two or more receivers due to spectral leakage from an upstream frequency band into a downstream frequency band and vice versa.

20. The method of claim 18, further comprising:

mitigating self-crosstalk to each of the one or more receivers of the multiline communications system using the Zipper scheme; and

utilizing a transmission scheme with non-overlapped upstream and downstream spectra with the multiline communications system,

wherein the self-crosstalk is caused by one or more transmitters, and by spectral leakage from an upstream frequency band into a downstream frequency band and vice versa.

21. The method of claim 18, further comprising:

mitigating self-echo to each of the one or more receivers of the multiline communications system using the Zipper scheme; and

utilizing a transmission scheme with overlapped upstream and downstream spectra with the multiline communications system,

wherein the self-echo is caused by one or more transmitters, and by spectral leakage from an upstream frequency band into a downstream frequency band and vice versa.

22. The method of claim 21, wherein mitigating self-echo comprises using a frequency-domain digital echo canceller in each of the one or more receivers of the multiline communications system, wherein the digital echo canceller comprises one single-tap echo cancellation filter in each of the frequency bins of the one or more frequency bins that are used by each receiver of the two or more receivers and are located in an overlapped part of the upstream band and downstream frequency band.

23. The method of claim 18, further comprising:

mitigating self-crosstalk to each receiver of the one or more receivers of the multiline communications system using the Zipper scheme; and

utilizing a transmission scheme with overlapped upstream and downstream spectra with the multiline communications system,

wherein the self-crosstalk is caused by one or more transmitters, and by overlap of an upstream frequency band and downstream frequency band.

24. The method of claim 23, further comprising:

mitigating the self-crosstalk by using a frequency-domain vector digital crosstalk canceller in each receiver of the two ore more receivers of the multiline communications system, wherein the vector digital crosstalk canceller comprises a set of single-tap crosstalk cancellation filters in each frequency bin of the two or more frequency bins that are used by each receiver of the two or more receivers and are located in the overlapped upstream and downstream frequency spectra, where there is one less single-tap crosstalk cancellation filter than transmitters of the multiline communications system.

25. A system, comprising means for mitigating spectral leakage in DMT (Discrete Multi-Tone) receivers, wherein mitigating spectral leakage comprises means for designing a receiver window to reduce edge effects of an IFFT/FFT transformation.

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26. The system of claim 25, further comprising means for designing a shape of the receiver window by maximizing a bitrate of a DMT system for a given set of disturber environments.

27. The system of claim 25, further comprising means for determining a length of the receiver window by maximizing a bitrate of a DMT system for the given set of disturber environments.

28. The system of claim 25, further comprising:

means for applying the receiver window to a received signal in a time domain; and

means for using a FFT to convert the received signal into a frequency-domain symbol.

29. The system of claim 28, wherein the shape of the receiver window is linear.

30. The system of claim 28, wherein the length of the receiver window is between 5 and 20 samples.

31. The system of claim 28, further comprising means for reducing the length of the receiver window by not including 0 as a first coefficient or 1 as a last coefficient in receiver window coefficients.

32. The system of claim 31, further comprising:

means for multiplying samples in a last part of a prefix of the received signal by the receiver window coefficients to generate a first result;

means for multiplying the samples in the last part by the receiver window coefficients subtracted from 1 to generate a second result; and

means for adding the first result and second result to generate modified samples; and

means for substituting the modified samples into the last part of the received signal.

33. The system of claim 25, further comprising means for using the receiver window in a multiline communications system having multiple twisted copper pairs as a single

multiline communications channel, and physical-layer signals coordinated across multiple transmitters and/or across multiple receivers.

34. The system of claim 33, further comprising means for using the receiver window to mitigate spectral leakage across one or more frequency bins and across one or more receivers of the multiline communications system.

35. The system of claim 33, further comprising means for determining a shape of the receiver window by maximizing a bitrate of a DMT system for a given set of disturber environments.

36. The system of claim 33, means for determining a length of the receiver window by maximizing a bitrate of a DMT system for the given set of disturber environments.

37. The system of claim 33, further comprising:

means for applying the receiver window to a received signal in a time domain; and

means for using a FFT to convert the received signal into a frequency-domain symbol.

38. The system of claim 37, wherein the shape of the receiver window is linear.

39. The system of claim 37, wherein the length of the receiver window is between 5 and 20 samples.

40. The system of claim 37, further comprising means for reducing the length of the receiver window by not including 0 as a first coefficient or 1 as a last coefficient in receiver window coefficients.

41. The system of claim 37, further comprising:

means for multiplying samples in a last part of a prefix of the received signal by the receiver window coefficients to generate a first result;

means for multiplying the samples in the last part by the receiver window coefficients means for subtracted from 1 to generate a second result;

means for adding the first result and second result to generate modified samples; and

means for substituting the modified samples into the last part of the received signal.

42. A system, comprising:

means for mitigating crosstalk between multiple lines of a multiline communications system, comprising means for using a Zipper scheme, including a prefix and suffix, to synchronize transmitters and receivers across the multiple lines of the multiline communications system, wherein the multiline communications system has multiple twisted copper pairs as a single multiline communications channel, and physical-layer signals coordinated across multiple transmitters and/or across multiple receivers.

43. The system of claim 42, further comprising:

means for using a transmission scheme with non-overlapped upstream and downstream spectra; and

means for mitigating self-echo to each receiver of the two or more receivers using the Zipper scheme, wherein the self-echo is caused by a transmitter corresponding to each receiver of the two or more receivers due to spectral leakage from an upstream frequency band into a downstream frequency band and vice versa.

44. The system of claim 42, further comprising:

means for mitigating self-crosstalk to each of the one or more receivers of the multiline communications system using the Zipper scheme; and

means for utilizing a transmission scheme with non-overlapped upstream and downstream spectra with the multiline communications system,

wherein the self-crosstalk is caused by one or more transmitters, and by spectral leakage from an upstream frequency band into a downstream frequency band and vice versa.

45. The system of claim 42, further comprising:

means for mitigating self-echo to each of the one or more receivers of the multiline communications system using the Zipper scheme; and

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means for utilizing a transmission scheme with overlapped upstream and downstream spectra with the multiline communications system,

wherein the self-echo is caused by one or more transmitters, and by spectral leakage from an upstream frequency band into a downstream frequency band and vice versa.

46. The system of claim 45, wherein means for mitigating self-echo comprises means for using a frequency-domain digital echo canceller in each of the one or more receivers of the multiline communications system, wherein the digital echo canceller comprises one single-tap echo cancellation filter in each of the frequency bins of the one or more frequency bins that are used by each receiver of the two or more receivers and are located in an overlapped part of the upstream band and downstream frequency band.

47. The system of claim 42, further comprising:

means for mitigating self-crosstalk to each receiver of the one or more receivers of the multiline communications system using the Zipper scheme; and

means for utilizing a transmission scheme with overlapped upstream and downstream spectra with the multiline communications system,

wherein the self-crosstalk is caused by one or more transmitters, and by overlap of an upstream frequency band and downstream frequency band.

48. The system of claim 47, further comprising:

means for mitigating the self-crosstalk by using a frequency-domain vector digital crosstalk canceller in each receiver of the two ore more receivers of the multiline communications system, wherein the vector digital crosstalk canceller comprises a set of single-tap crosstalk cancellation filters in each frequency bin of the two or more frequency bins that are used by each receiver of the two or more receivers and are located in the overlapped upstream and downstream frequency spectra, where there is one less single-tap crosstalk cancellation filter than transmitters of the multiline communications system.

49. A computer readable medium, having stored thereon computer-readable instructions, which when executed in a computer system, cause the computer system to

mitigate spectral leakage in DMT (Discrete Multi-Tone) receivers by using a receiver window to reduce edge effects of an IFFT/FFT transformation.

50. The computer readable medium of claim 49, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to design a shape of the receiver window by maximizing a bitrate of a DMT system for a given set of disturber environments.

51. The computer readable medium of claim 49, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to determine a length of the receiver window by maximizing a bitrate of a DMT system for the given set of disturber environments.

52. The computer readable medium of claim 49, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to:

apply the receiver window to a received signal in a time domain; and

use a FFT to convert the received signal into a frequency-domain symbol.

53. The computer readable medium of claim 52, wherein the shape of the receiver window is linear.

54. The computer readable medium of claim 52 wherein the length of the receiver window is between 5 and 20 samples.

55. The computer readable medium of claim 52, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to reduce the length of the receiver window by not including 0 as a first coefficient or 1 as a last coefficient in receiver window coefficients.

56. The computer readable medium of claim 55, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to:

multiply samples in a last part of a prefix of the received signal by the receiver window coefficients to generate a first result;

multiply the samples in the last part by the receiver window coefficients subtracted from 1 to generate a second result;

add the first result and second result to generate modified samples; and

substitute the modified samples into the last part of the received signal.

57. The computer readable medium of claim 49, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to use the receiver window in a multiline communications system having multiple twisted copper pairs as a single multiline communications channel, and physical-layer signals coordinated across multiple transmitters and/or across multiple receivers.

58. The computer readable medium of claim 57, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to use the receiver window to mitigate spectral leakage across one or more frequency bins and across one or more receivers of the multiline communications system.

59. The computer readable medium of claim 57, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to determine a shape of the receiver window by maximizing a bitrate of a DMT system for a given set of disturber environments.

60. The computer readable medium of claim 57, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to determine a length of the receiver window by maximizing a bitrate of a DMT system for the given set of disturber environments.

61. The computer readable medium of claim 57, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to:

apply the receiver window to a received signal in a time domain; and

use a FFT to convert the received signal into a frequency-domain symbol.

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62. The computer readable medium of claim 61, wherein the shape of the receiver window is linear.

63. The computer readable medium of claim 61, wherein the length of the receiver window is between 5 and 20 samples.

64. The computer readable medium of claim 61, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to reduce the length of the receiver window by not including 0 as a first coefficient or 1 as a last coefficient in receiver window coefficients.

65. The computer readable medium of claim 61, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to:

multiply samples in a last part of a prefix of the received signal by the receiver window coefficients to generate a first result;

multiply the samples in the last part by the receiver window coefficients subtracted from 1 to generate a second result; and

add the first result and second result to generate modified samples; and

substituting the modified samples into the last part of the received signal.

66. A computer readable medium, having stored thereon computer-readable instructions, which when executed in a computer system, cause the computer system to:

mitigate crosstalk between multiple lines of a multiline communications system by using a Zipper scheme, including a prefix and suffix, to synchronize transmitters and receivers across the multiple lines of the multiline communications system, wherein the multiline communications system has multiple twisted copper pairs as a single multiline communications channel, and physical-layer signals coordinated across multiple transmitters and/or across multiple receivers.

67. The computer readable medium of claim 66, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to:

use a transmission scheme with non-overlapped upstream and downstream spectra; and

mitigate self-echo to each receiver of the two or more receivers using the Zipper scheme, wherein the self-echo is caused by a transmitter corresponding to each receiver of the two or more receivers due to spectral leakage from an upstream frequency band into a downstream frequency band and vice versa.

68. The computer readable medium of claim 66, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to:

mitigate self-crosstalk to each of the one or more receivers of the multiline communications system using the Zipper scheme; and

utilize a transmission scheme with non-overlapped upstream and downstream spectra with the multiline communications system,

wherein the self-crosstalk is caused by one or more transmitters, and by spectral leakage from an upstream frequency band into a downstream frequency band and vice versa.

69. The computer readable medium of claim 66, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to:

mitigate self-echo to each of the one or more receivers of the multiline communications system using the Zipper scheme; and

utilize a transmission scheme with overlapped upstream and downstream spectra with the multiline communications system,

wherein the self-echo is caused by one or more transmitters, and by spectral leakage from an upstream frequency band into a downstream frequency band and vice versa.

70. The computer readable medium of claim 69, further having stored thereon computer-readable instructions, which when executed in the computer system to mitigate self-echo, cause the computer system to use a frequency-domain digital echo canceller in each of the one or more receivers of the multiline communications system, wherein the

digital echo canceller comprises one single-tap echo cancellation filter in each of the frequency bins of the one or more frequency bins that are used by each receiver of the two or more receivers and are located in an overlapped part of the upstream band and downstream frequency band.

71. The computer readable medium of claim 66, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to:

mitigate self-crosstalk to each receiver of the one or more receivers of the multiline communications system using the Zipper scheme; and

utilize a transmission scheme with overlapped upstream and downstream spectra with the multiline communications system,

wherein the self-crosstalk is caused by one or more transmitters, and by overlap of an upstream frequency band and downstream frequency band.

72. The computer readable medium of claim 71, further having stored thereon computer-readable instructions, which when executed in the computer system, cause the computer system to:

mitigate the self-crosstalk by using a frequency-domain vector digital crosstalk canceller in each receiver of the two ore more receivers of the multiline communications system, wherein the vector digital crosstalk canceller comprises a set of single-tap crosstalk cancellation filters in each frequency bin of the two or more frequency bins that are used by each receiver of the two or more receivers and are located in the overlapped upstream and downstream frequency spectra, where there is one less single-tap crosstalk cancellation filter than transmitters of the multiline communications system.